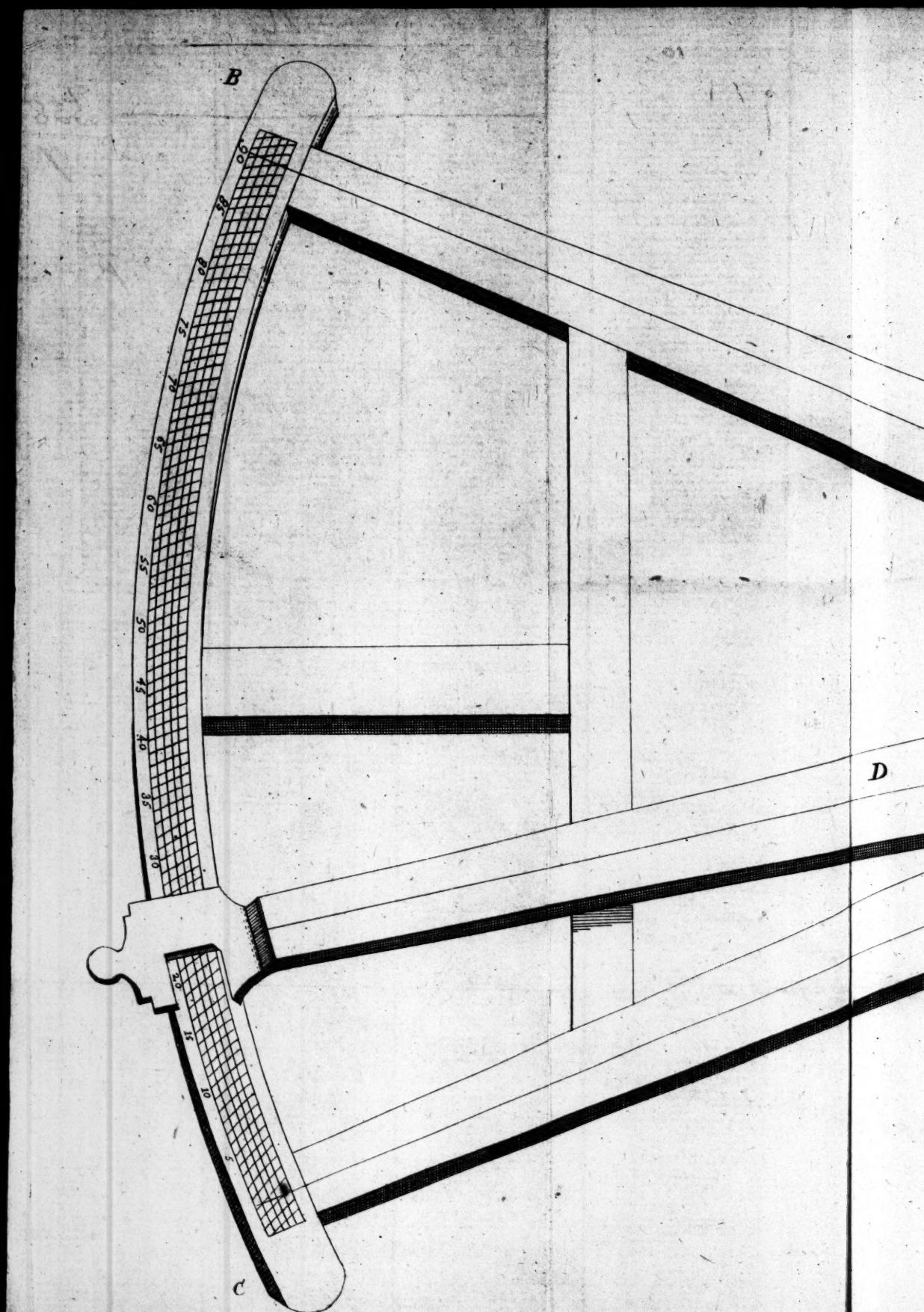
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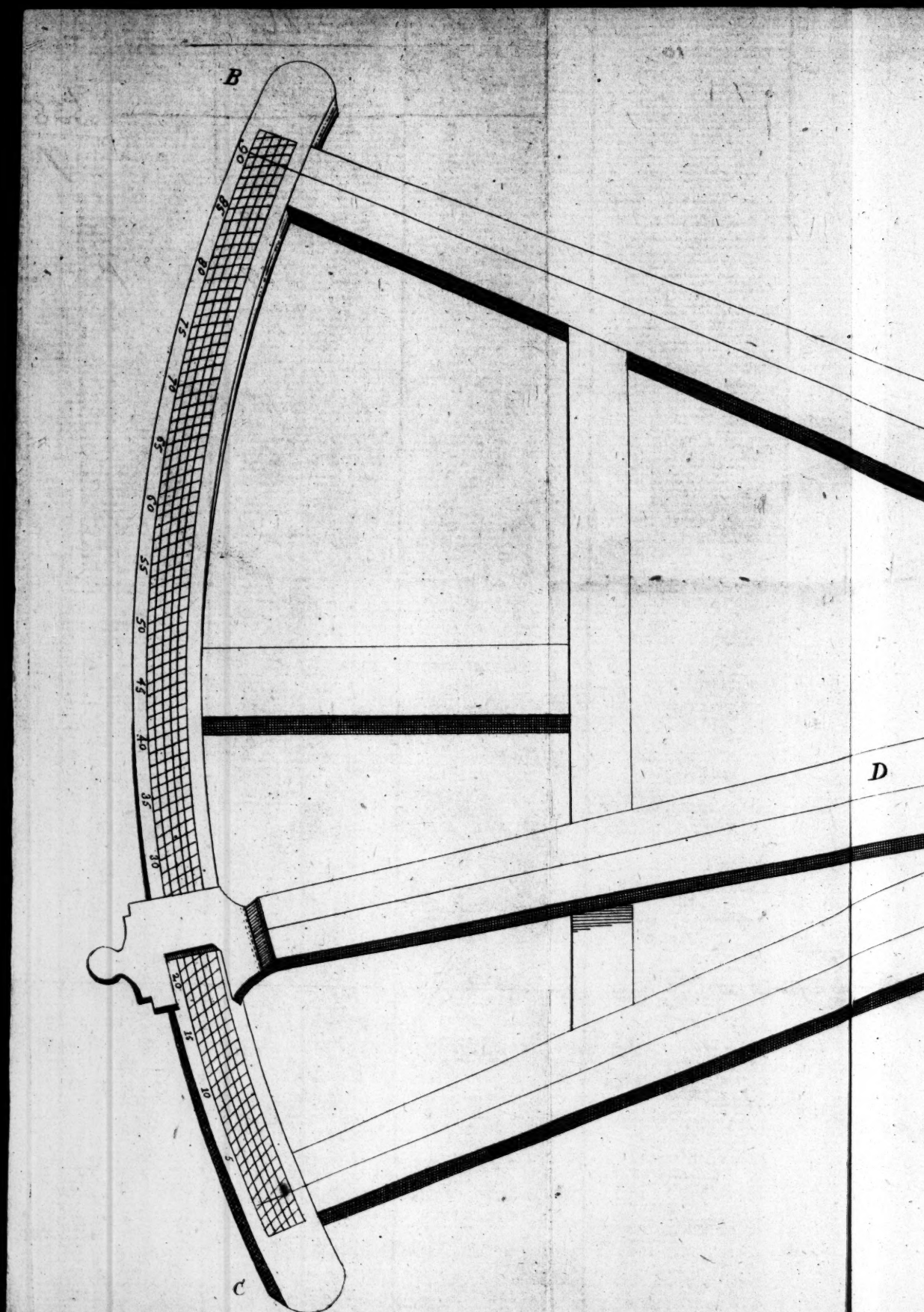
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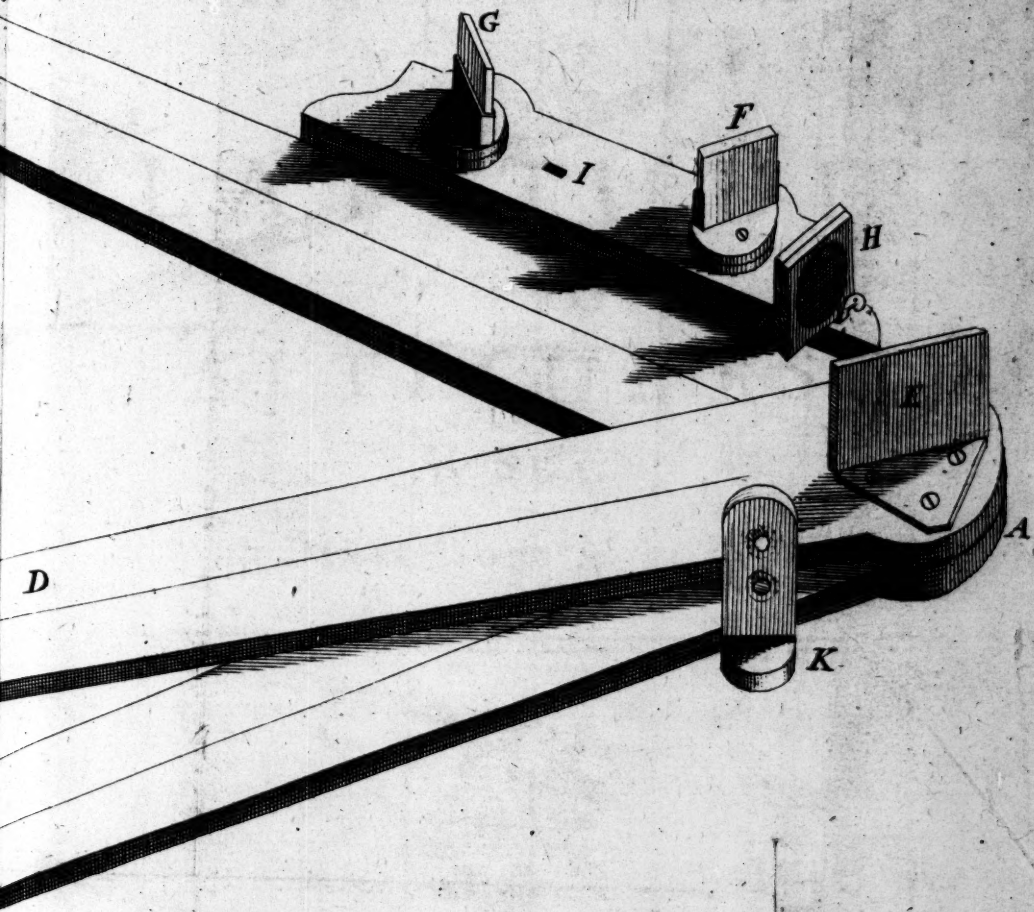
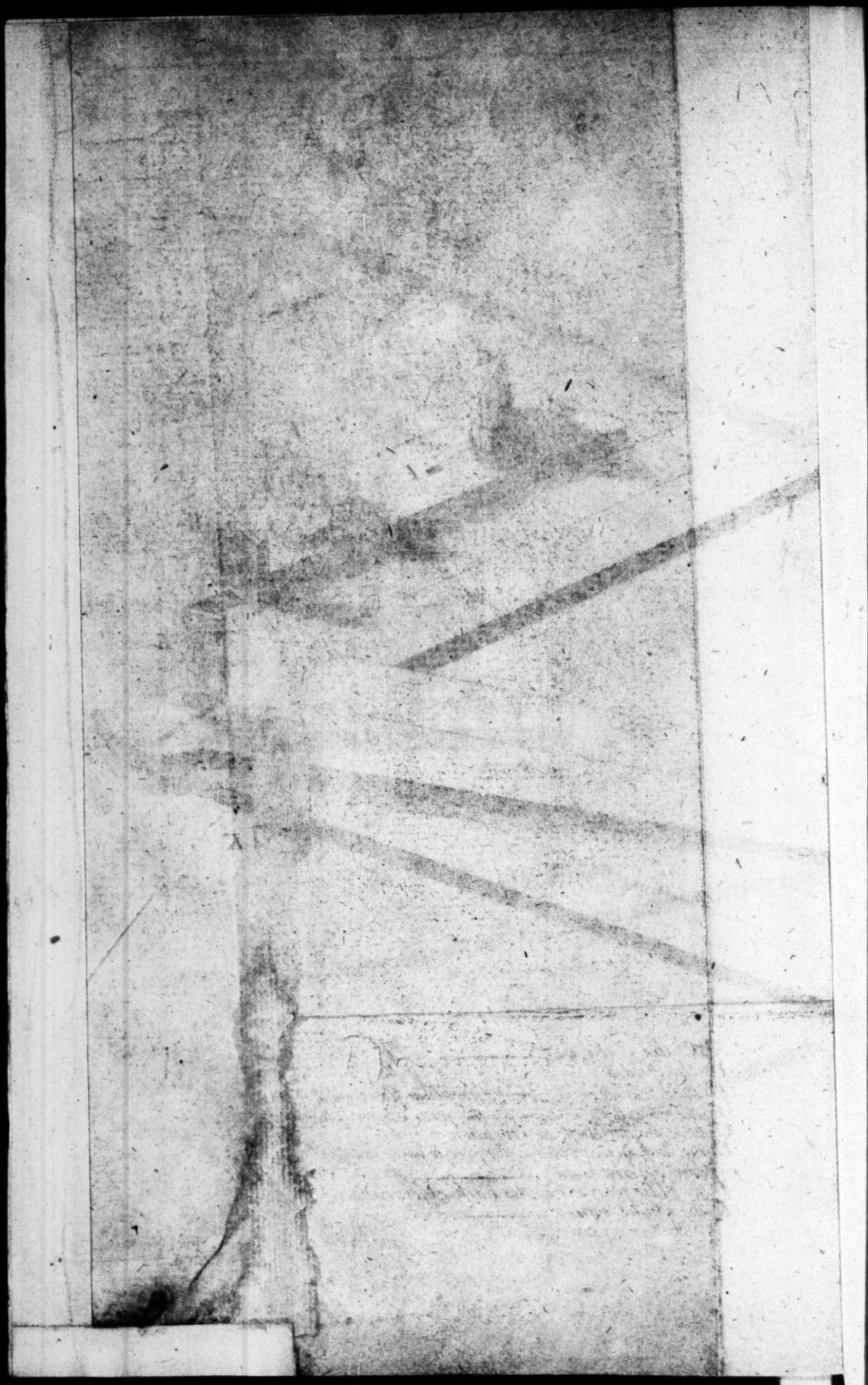


ABC the Octant
D the Index
E the backside of the great Speculum fixed on it
F the small Speculum for the fore Observation
G that for the back observation
H the dark Glasses placd as they are to be in the fore observation
I the place for them in the back observation
K the Sight vane



A

DESCRIPTION

OF A

New Instrument

For taking the

LATITUDE

OR OTHER

ALTITUDES

At SEA.

With DIRECTIONS for its USE.

LONDON:

Printed for the AUTHOR, MDCCXXXIV.

A

DESCRIPTION

OF A

New INSTRUMENT

For taking the LATITUDE *or other* ALTITUDES *at Sea.*

THE Inſtrument conſiſts of an Octant, its Arch containing but 45 Degrees, but half Degrees by the Nature of Reflections anſwering to whole ones; it is graduated into 90 equal Parts (with proper Subdiviſions) which are ſo many Degrees, and ſerve to take any Altitude from the Horizon to the Zenith. It hath an Index turning on a Pin in the Center, the other End ſliding on the graduated Arch, where it marks the Diviſions.

At the Center is placed a Piece of Looking-glaſs quickſilver'd, ſet in Braſs, and fixed on the Index, perpendicular to the Plane

of the Inſtrument. This Glaſs is to receive the firſt Image of the Sun, or other Object, to be obſerved by, and to reflect it to another leſſer Piece of Looking-glaſs, placed on one of the Limbs, that Part of it only which is next the Plane of the Inſtrument being quickſilvered, and ſo ſet in its Braſs Work, that it may at any time be ſet perpendicular to the Plane of the Inſtrument, if the ſame by Warping, or any other Accident, ſhould be removed from that Poſture. When it is in the Perpendicular, it can alſo be turned round, keeping ſtill perpendicular, ſo as at pleaſure to bring it to its true Poſition in reſpect of the Glaſs fixed on the Index. This Glaſs is for Forward Obſervations, and from it the Eye receives the Image of the Object by a ſecond Reflection.

For the Back Obſervation there is another ſuch ſmall Glaſs, placed on the ſame Limb as the former, but farther from the Center, and with juſt ſuch Braſs Work to ſet it, both Perpendicular, and in its true Poſition.

There are two dark Glaſſes, ſet in Frames of Braſs fixed to a Pin, the one lighter, the other darker, ſo as at pleaſure to be turned, either of them, or both together, as the Sun's Brightneſs may require, between the Glaſs on the Index, and either of the two Glaſſes on the Limb, according as the Fore or Back Obſervation is uſed; for which Reaſon there

are

are two Holes in the Limb, that they may be accordingly ſhifted from on to the other.

There is uſed a Sight-Vane, which may be ſhifted from one Limb to the other, according to which Obſervation is uſed: In it are made two Holes, to direct the placing the Eye; the one being juſt ſo high above the Plane of the Inſtrument as is the middle of the unquickſilvered Part of the leſſer Glaſſes, the other about the Height of the Edge of the Quickſilver itſelf, or a little lower. There is great Curioſity in the Glaſſes; for a common Piece of Looking-glaſs will ſeldom do: They ought to be free from Veins, but above all, moſt perfectly flat, and of an equal Thickneſs, that thereby both Surfaces may be perfectly parallel to one another, in order to have but one Image by Reflection. The dark Glaſſes muſt likewiſe be very true; however, theſe do not require the ſame Exactneſs as the former which give the Reflection. The Buyer may eaſily know whether the Glaſſes be good, by taking notice of any bright Image, eſpecially of the Sun, ſeen after the two Reflections, whether the Edges of it appear perfectly ſharp, and diſtinct, and in one, which can never be, except the Glaſſes are as has been ſaid above, and they are beſt tried by a great Altitude, when the Index is towards 90 Degrees, which will ſhew the Errors moſt.

The

The Figure prefixed will better deſcribe this Inſtrument than any Words alone can do. There are other Draughts of it in *Phil. Tranſ.* No. 420. with a Mathematical Account of the Principles it is founded on, and its ſeveral Properties and Uſes, to which I chuſe to refer the more Curious, this being deſigned rather for thoſe not ſo much verſed in Mathematicks.

The Altitude of the Sun, or a Star, from the Horizon, taken by this Inſtrument, is determined by the Inclination of the Planes of the two Glaſſes to each other, when the Object appears in the Horizon, that is, of either of the leſſer Glaſſes to that larger one fixt on the Index; for the two leſſer are quite independent of one another. In the Fore Obſervation, the Double of this Angle of Inclination is the Altitude ſought, and is marked by the Index on the Arch divided into half Degrees, as is ſaid above. In the Back Obſervation, double the Difference of this Inclination from a Right Angle, gives the ſame Altitude, and is marked by the Index in the ſame manner, the ſame Scale of Degrees ſerving indifferently for both. So that when the Index ſtands at the Beginning of the Scale, the Surface of the leſſer Glaſs, uſed for the Fore Obſervation, is exactly parallel to the Surface of that on the Index; but the Surface of the other leſſer Glaſs, uſed for the

the Back Obſervation, is at Right Angles to the ſame.

The Manner of obſerving is this: The Inſtrument being held as near as can be, in the Verticle Circle paſſing through the Object, with the Arch downwards (it being contrived for that Poſture, both as being moſt convenient for the Obſerver, and becauſe that ſo the Inſtrument is leaſt expoſed to the Wind) and the Eye placed at the Sight-Vane, the Obſerver muſt look at the Edge of the Sea, and ſee it without any Reflection, with a direct View, through the unquickſilvered Part of the leſſer Glaſs on the Limb; and then, by moving the Index forward, the Image of the Object, whoſe Altitude is ſought, muſt be brought to appear as if it was really joined with the Edge of the Water. If the Object be bright enough, as the Sun almoſt always is, the Obſerver may take the reflected Image on the unquickſilvered Part of the Glaſs, at the ſame time he ſees the Horizon through it directly; and the Eye will have no more to do but to obſerve them both when joined together, and then look what Degrees, and Minutes, the Index cuts on the Arch. But if the Object be faint (as ſuppoſe the Sun when covered with thin Clouds, or a Star) it muſt then be taken on the quickſilvered Part of the Glaſs, and you muſt judge when the Line of the Horizon, ſeen directly through

the

the other Part of the Glaſs which is unquick-ſilvered, if produced, would paſs through the Sun, or Star, taking care in either Caſe to keep the Line of Direction of the Sight, that is, the Line in which you ſee the Image, as near as may be parallel with the Plane of the Inſtrument: For which Reaſon, if the Sun be bright enough, take your Obſervation on the Middle of the unquickſilvered Part of the Glaſs, and look through the outward Hole in the Sight-Vane; but if the Sun be too faint, or you uſe a Star, take your Obſervation near the Edge on the quickſilvered Part, and look through the lower Hole that is next the Inſtrument.

When the Object is brought down to appear in or near the Horizon, let the Obſerver turn the Inſtrument a little awry from right to left by turns, by which the Image in either Obſervation will ſlide to and again along the Horizon, if the Index is exactly ſet; if it run in a Line, cutting the Edge of the Sea, 'tis a ſign the Inſtrument is not held upright. As to the Motion of the Inſtrument up, and down, the Image will not in the leaſt be removed by it from the Edge of the Sea.

In taking the Altitude of the Sun, if a correct Obſervation is deſired, it will not be ſo well to uſe its Center, becauſe the Diameter of the Sun being about 32 Minutes, which

which is above half a Degree, it is not ſo eaſy to judge when the Center is juſt in the Line of the Horizon. The beſt way therefore will be to take the Altitude by the upper, or under Edge, and accordingly ſubſtract or add 16 Minutes for the Semi-diameter.

In the Fore Obſervation the Image of any Object, after the two Reflections, appears in the ſame Poſture as when ſeen by the naked Eye, that is, the Object is not inverted, but what in reality is above, or under, is the ſame in appearance when ſeen by Reflection: In the Fore Obſervation, if the loweſt Edge of the Sun be brought to touch the Edge of the Sea, add 16 Minutes; if the Altitude be taken by the upper Edge, ſo much is to be ſubſtracted from the Degrees and Minutes marked by the Index on the Arch, and the true Altitude will be given.

By the Back Obſervation, on the contrary, the Object is inverted, that is, the Edge of the Sun, which in reality is higheſt, when ſeen by Reflection appears undermoſt; therefore add or ſubſtract the contrary way to the Rule of the Fore Obſervation, that is, in taking the Altitude by the Edge which appears loweſt, ſubſtract 16 Minutes; if by the Edge which appears higheſt, add as much.

If the Obſervation be made by a Star, the beſt way will be (eſpecially if it be high) to look firſt directly up at it, the Index ſtand-

ing at the Beginning of the Scale of Degrees; for, by this means, the Star ſeen by Reflection will appear in the ſame Place it is ſeen in by direct View; then, by ſliding the Index, the Image will run down till it touch the Horizon, without your loſing Sight of it. The uſe of this Caution is, leaſt when Stars of the ſame Degree of Brightneſs lye near one another, the Obſerver ſhould miſtake that he intends to make uſe of. The Altitude of a Star is thus taken by the Fore Obſervation; but when the Horizon is bright, and the Star faint, it may be more convenient to take its Altitude by the Back Way; in which Caſe you are to look directly up at the Star, and bring the Horizon, or Edge of the Sea behind you, to touch the Star by Reflection. As the Stars muſt be uſed always in the Night, and the Horizon is then but obſcure, it may be of uſe to get down as near the Surface of the Water as you can, that you may ſhorten the Horizon, likewiſe to watch for Stars which come to the Meridian during Twilight, either after Sun-ſet, or before he riſes: Moonlight Nights may alſo be of uſe.

The Glaſſes are ſo contrived in their Braſs Work, as to be adjuſted at pleaſure as often as the ſame may be found neceſſary, and may be done very nicely by almoſt any Object a Mile or two off; but nothing is more

more convenient than the Edge of the Sea, becauſe it is a ſtreight Line. But as to the ſtanding of the Glaſſes perpendicular to the Plane of the Inſtrument, ſince that is not neceſſary to the making a good Obſervation, provided they are not far out of that Poſture, I ſhould give no Directions about it, but that there is no more in it, than to hold the Inſtrument in an horizontal Poſture, and ſetting the Index to the Beginning of the Arch, obſerve whether the Line of the Sea's Edge ſeen directly, and by Reflection, coincide, and make one Line; which if they do not, it may be eaſily rectified by the little Screws for that purpoſe in the upper round Plate on which the little Glaſſes ſtand, the great One on the Index being ſuppoſed to be firſt truly ſet, and keep its Poſture.

The adjuſting the other way is neceſſary, but ſtill more obvious, and eaſy. Take care only that the Index ſtand exactly at the Beginning of the Scale of Degrees, and then holding the Inſtrument in an upright Poſture, with the Arch downwards, juſt as has been directed when an Obſervation is to be taken, obſerve as before whether the Edge of the Sea ſeen by Reflection, coincide with, and make one Line with the Edge ſeen by direct View without Reflection; if not, by the Key which turns the Glaſs round, they muſt be brought into one Line, the Index ſtill ſtand-

ing at the Beginning of the Scale. Indeed this is ſcarce different from taking an Obſervation; for the Reflection being from the very ſame Object that is ſeen by the direct View, the Angle between them ought to be nothing; and therefore the Index when they appear joined together, muſt ſtand at the Beginning of the Scale on the Arch, and mark no Angle.

For adjuſting the Back Obſervation, bring in like manner the Edge of the Sea from behind you, to appear in one Line by Reflection, with the Edge of the Sea ſeen before you by direct View; but to be accurate, and make the Back and Fore Obſervation agree together (eſpecially if you be much elevated above the Surface of the Water in a lofty Ship) the Index muſt not ſtand exactly at the Beginning of the Scale, as is directed for adjuſting the Fore Obſervation, becauſe the Obſerver is not in the ſtreight Line between the two Horizons, but elevated above them both ways: For this Reaſon the Index muſt be ſet off ſo much before the Beginning of the Scale, as is double the Angle of the Dip of the viſible Horizon, which is the Edge of the Sea, below the true Horizon: Therefore there are a few Minutes graduated for this Purpoſe, before the Beginning of the Arch. For Example, ſuppoſe the Eye of the Obſerver be about eleven Feet above the Water, the Dip of the viſible Horizon will

will then be four Minutes forwards, and as much backwards; therefore the Index muſt be ſet off before the Beginning of the Scale eight Minutes, and then the Image of the Back Horizon muſt be brought to coincide in one Line with that before ſeen directly.

To be accurate in ſetting the two leſſer Glaſſes true to that fixed on the Index, when the Inſtrument is held with the Arch downwards, is much more material than the ſetting them perpendicular to the Plane of the Inſtrument; and there ought to be particular Care therein, that the Index continue, while it is doing, exactly placed; but the doing of it is ſo plain, and eaſy, and with ſo very little Loſs of Time, that there needs be no Objection to the examining whether the Glaſſes ſtand true, even every time the Inſtrument is uſed, not that it will be neceſſary; for if the Wood be well ſettled, and do not caſt, nor warp, the Glaſſes may ſtand true, and continue ſo always.

That the Obſerver can at any time at Sea thus examine and correct this Inſtrument, is a Convenience peculiar to it: For all other Inſtruments (tho' the Maker has been ever ſo faithful in his Workmanſhip) if they are made of Wood (as all common Inſtruments muſt be for Cheapneſs) will caſt, and warp, which muſt neceſſarily occaſion great Errors in the Obſervations made by them, and

yet

yet at the ſame time the Obſerver has no Method which he can uſe at Sea to find out the Errors, nor Tools, nor Art enough to amend them; and this is the Cauſe that we hear Seamen, when talking of their Inſtruments, ſay, They are Northerly, or Southerly, that is, ſome give the Latitude too great, and others too little, and that often ſeveral Inſtruments, uſed together for the ſame Obſervation, on board the ſame Ship (beſides the Differences ariſing from the Difficulty and Uncertainty in uſing them) differ as much more likewiſe through the Faults in the ſeveral Inſtruments themſelves; whereas in this, if they are but faithfully made, there can no material Error happen, farther than what proceeds from the ſhrinking, or ſwelling of the graduated Arch, which will ſeldom be conſiderable; ſo that the Glaſſes being by the foregoing Direction, but firſt adjuſted, the ſame Obſervations, made by ſeveral Inſtruments, will all agree together within a trifle, which is a great Aſſurance and Satisfaction to a Seaman, who by hard Gales, and variety of Traverſes, has been beat out of his Knowledge.

The chief Advantage of this Inſtrument conſiſts in this, that whereas in taking an Altitude by other Inſtruments now in uſe, there is required a certain exact Poſture of them; but the Motion of the Ship coninually

ally disturbs the Observer, by putting them out of that true Posture, even in moderate Weather, and in hollow Seas, to that degree, that there is no depending on Observations then taken; yet with this Instrument, tho' the Ship rowl ever so much, provided the Instrument be kept in or near the upright Posture, tho' it be leaned forward or backward therein, yet the Image of any Object, when once brought by sliding the Index to appear on the Edge of the Sea, will there remain absolutely immoveable, as long as the Index continues in the same Place without being stirred, and the Observer has the same Advantage of making his Observation accurate, as if he took it in smooth Water, and the Instrument was held still without Motion. By the other Motion in turning the Instrument awry, as has been directed above, the Image will have a side Motion; but there is a Convenience arising from it, in as much as the Observer, by this Motion of the Object, may know when he holds his Instrument in a true upright Posture; so that this Property may be made a Benefit, and helps to ascertain an Observation, better than if it had no such Motion at all. This kind of Motion in other Instruments now in use, is not what absolutely spoils an Observation, tho' it always does some Harm; but it is the Motion up and down, the least Degree of that being so

ſo much Deviation from that true Poſture, in which thoſe Inſtruments ought neceſſarily to be held, at the Inſtant the Obſervation is taken; which, however, in this Inſtrument has not the leaſt Effect, but the Image of the Object remains immoveably fixed on the Edge of the Sea. The Reaſon why it is ſo, is, becauſe, juſt as much as the Image is thrown downwards, or upwards, by the Change of the Poſture of the firſt Glaſs fixed on the Index, which immediately receives the firſt Image of the Object, (occaſioned by the Pitching, and Rowling of the Ship, or Motion of the Hand,) juſt ſo much is it carried the contrary way by the ſecond Glaſs from which the Eye receives it.

There is another Inconvenience, which all other Inſtruments, which require an Horizon, are ſubject to, ariſing from the Nature of the Eye, becauſe it cannot ſee Things near, and at a diſtance, diſtinctly at the ſame Time. This any one may be preſently convinced of, that will but try the Experiment. And it muſt hinder an accurate Obſervation, where the Obſerver is obliged to ſee the Edge of the Sea five or ſix Miles off, and the Shadow, or Image of the Sun on his Inſtrument, which is not above two Feet from his Eye at the ſame time. In this Inſtrument it is quite otherwiſe; for the Sun after Reflection appears at the ſame Diſtance, as if looked at directly;

directly; ſo that one Poſture of the Eye ſerves to look at Sun, and Horizon, and ſee them perfectly, and diſtinct together.

Another Advantage of this Inſtrument is, that it admits of more frequent Obſervations, than any other which requires an Horizon; for, here the Body of the Sun, if it can but be diſcerned through the Clouds, appears juſt in the ſame manner by Reflection, as it does when ſeen directly, and often with this farther Convenience, of ſeeing his Body diſtinctly through the dark Glaſſes, when he is all in a glare to the naked Eye; and, as it at the ſame Time ſtands ſtill without dancing upon the Edge of the Sea, tho' the Inſtrument be in Motion, the Obſerver has the Opportunity of looking with the ſame Attention at the Horizon, as when he looks at it without obſerving; ſo that if the Obſerver can but juſt diſcern the fainteſt Mark of the Sea's Edge, he will be able to make a very ſure Obſervation. There is nothing of this Kind to be done, to any Certainty, with any of the Inſtruments now in Uſe, without a tolerable bright Sun, and good Horizon, becauſe of the dancing of the Image, which makes either of them ſtill more difficult to be diſcerned; in ſo much that an Obſervation taken in hazy Weather, which ſeems to be pretty good, yet if by chance the Weather clears up, and the

Sun breaks out bright, is ſometimes found twenty Minutes, and more, out from this Circumſtance alone. This, in the preſent Inſtrument, may be of ſingular Service often, in making the Channel, which in the Winter Months is very ſubject to thick hazy Weather.

Another Advantage in this Inſtrument is, that the Sun's Altitude may be eaſier taken when he is near the Zenith than by others, eſpecially if the Obſerver be not very expert, becauſe, by this it can be done immediately; for, the Sun, when his Altitude is great, croſſes the Meridian too faſt to admit of any Delays. This will be a great Convenience to all Ships in general, which uſe ſouthern Voyages, eſpecially if they lie within the Tropicks, where the Sun muſt neceſſarily be high when upon the Meridian; in particular to the *India-men*, in hitting the Iſland of St. *Helena*, in which they are often put to Difficulties, for want of a good Latitude, to fall in with it; to Ships bound for *Barbados*, and the other ſmaller Iſlands in the *Weſt-Indies*; as alſo to Ships bound to the Coaſts of *Angola*, where they have often no better Means to find their Road, than by enquiring along Shoar, whether it lie to the Northward or Southward. All Sloops bound from *North America* to the *Bermudas Iſlands*, make it almoſt a Rule, if they

they cannot readily hit thoſe Iſlands, which are very low, and lie almoſt Eaſt and Weſt in length, to run away to the *Weſt-Indies*, which proceeds from the want of an exacter Latitude, which is there difficult to take, when the Sun has much Declination Northerly.

Another Advantage is the Uſe of the Stars, ſome of the brighter of which may often afford a very good Obſervation, for want of one by the Sun, when they happen to come on the Meridian, during the time of the Morning, or Evening Twilight, and in Moonlight Nights.

Theſe ſeveral Circumſtances render this Inſtrument much preferable to the others now in uſe: There remains ſtill to be added, that it is ſo eaſy to obſerve with it, that a Stranger to it can hardly believe it beforehand, till he has been convinced by a Trial. It may be learnt immediately, and a Landman that has ſcarce got his Sea-Legs, as the Phraſe is, may take an Obſervation at the firſt Attempt. A Seaman can make nothing of an Obſervation at firſt with the common Inſtruments; he muſt have practiſed a long time before he can become a good Obſerver, becauſe they require a great deal of Dexterity in the handling them, and humouring the Motions of the Ship, as well as a ſharp Eye; ſo that at

beſt, the taking of an Obſervation by them requires great Care, and takes up Time; for the Obſerver muſt attend a ſufficient Time before the Sun comes to his greateſt Height, and be ſure to ſtay till he is fallen again, before he leaves off, which, for want of an accurate Inſtrument, he is much longer being aſſured of, than he will need to be with the preſent Inſtrument; for the leaſt Riſe or Fall of the Sun may be perceived, which will very much leſſen the Fatigue of taking an Obſervation.

There was a Trial made of this Inſtrument, at Sea, by Order of the Lords of the Admiralty, on board the *Chatham Yatch*, in the Autumn of the Year 1732, in Preſence of ſeveral Members of the Royal Society, and of one of the Maſter Attendants of His Majeſty's Yard at *Chatham*. The Obſervations were made by the Help of ſome curious Watches, with Second Hands; and from the Time by the Watch correct, noted at the Inſtant of each Obſervation, the true apparent Altitude of the Sun was computed, the Refraction, and Dip from the Obſervers being elevated above the true Horizon, being duly allowed for, and the Difference between the Altitude, thus found by Computation, and what was given by the Inſtrument at the ſame Time, gives the Quantity of the Error in Obſervation.

You have hereunder the Reſult of that Trial, as it was afterwards communicated to the Royal Society, in which, here, for brevity ſake, the Errors of Obſervation only are ſet down. See *Phil. Tranſ.* No. where the Whole is printed at length.

m. s.	m. s	m. s.	m. s	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.
0 40	0 31	2 34	1 06	2 07	1 38	2 43	0 06	0 20	0 24	
1 02	1 31	2 15	0 25	0 56	2 11	3 02	1 28	0 20	1 03	
0 49	0 04	1 20	1 37	1 02	9 05	0 32	0 41	0 00	1 59	
0 35	0 01	0 42	1 43	1 09	1 46	1 06	0 49	0 4	0 35	
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0 37	4 09	1 16	0 26	0 03	0 52	1 14	0 19	1 18	2 42	
0 29	5 16	1 45	0 07	1 35	1 58	0 36	0 23	2 00	0 27	
0 05	3 33	0 21	2 02	0 54	1 15	11 54	0 28	3 24	2 32	
									0 52	

The Number of Obſervations in the foregoing Table, of which near a third Part were made by the Back Obſervation, the reſt forward, is 81. There are three or four great Errors, probably produced either by miſcounting the Time by the Watch, or Diviſions of the Inſtrument; for of 62 of them, the Error is under 2 Minutes, and 40 of them under one Minute.

But what Degree of Exactneſs might reaſonably be depended on, in Altitudes taken by this Inſtrument, by thoſe uſed to the Motion of a Ship at Sea, which, during theſe Obſervations, was very great, and to which the Gentlemen, who made them, were altogether unaccuſtomed, cannot be

ſo well aſcertained, without a greater Number of Obſervations taken near the Meridian: For the Sun, when conſiderably diſtant from it, alters ſo faſt, as ſometimes to make 8 or 9 Minutes Difference of Altitude, in one Minute of Time, in our Latitude; conſequently 6 or 7 Seconds, Error in Time, will be ſufficient to cauſe one whole Minute's Error in the Altitude; add to this, that this quick Alteration of Altitude hinders the Obſerver's dwelling ſufficiently on his Obſervation, to fix it ſo nicely; whereas thoſe taken at, or near Noon, are attended with none of theſe Difficulties; and this probably is the Reaſon, why the Obſervations taken near Noon proved the moſt accurate, and that the other Errors, how inconſiderable ſoever in general, would probably have been ſtill leſs ſo, had the Obſervations been all taken in like manner near the Meridian.

Since the Obſervations in the foregoing Table were attended with the Difficulties abovementioned, it may be preſumed, that generally, a Latitude which is taken by this Inſtrument by an Object, when it is upon the Meridian, may be depended on to one Minute. And though ſeveral Seamen ſay, that 10 or 20 Miles is nothing at Sea, and ſo great an Exactneſs is not neceſſary; yet it will appear to be of ſingular

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Advantage, and a great Improvement to Navigation, to be aſſured of the Latitude to ſuch Nicety, if what follows be duly conſidered; often, in reſpect of knowing the Latitude only, but much more in reſpect of the Dead Reckoning, which, by Means thereof, may be very much corrected, beyond what it can at preſent be; for when the Courſe lies much Eaſterly, or Weſterly, the Correction by an Obſervation, by the Inſtruments uſed at preſent, cannot poſſibly be of any great Uſe, for want of more Exactneſs. To give one Example, which may ſerve for all: Suppoſe a Ship departs from a Head-Land whoſe Latitude is known, and in 48 Hours, by Dead Reckoning, runs 400 Miles, the Courſe made good with all proper Allowances of Variation, Lee-way, *&c.* being by Judgment Weſt-South-Weſt, there the Run is at the Rate of about 8 Knots, conſequently high Winds, and hollow Seas: The Rhumb here is within two Points of the Weſt, making an Angle with the Parallel of 22 Degrees and an half; admit that the ſecond Day at Noon there be an Opportunity for an Obſervation, yet the Inſtruments now in uſe being not to be depended on ſufficiently (eſpecially the Sea running high, as it muſt in this Caſe) the Latitude given by the Dead Reckoning is ſafer to be relied

on,

on, in ſo ſhort a Run, and that lies ſo near the Parallel, than what you can obtain by Obſervation But when you can depend upon the Obſervation to one or two Minutes, whenever you find the leaſt Difference between the obſerved Latitude and that given by Dead Reckoning, there will be great Opportunity in every little Run, as often as Obſervation can be made, of examining which Way ſuch Error in the Dead Reckoning may have happened, whether in Courſe, or Diſtance, and of correcting the ſame. Therefore, whoever keeps a Reckoning carefully, and according to Art, will, by means of ſuch an Inſtrument, be abundantly aſſiſted, in computing the Quantity of the Eaſting and Weſting, in in all Voyages where there is not due Eaſt, or Weſt, along a Parallel, that is, will be much ſurer of his Longitude, and not be obliged upon drawing near Land, to lie by Night after Night, as is often the Way at preſent, for want of a more certain Knowledge of it, and thereby run thoſe many Hazards which are the neceſſary Conſequences of ſo doing. The being thus obliged to lie by, is in no Caſe more dangerous than for Ships that are making the Channel, which Caution they are often forced to in the Winter Seaſon, after long Voyages, and variety of Traverſes, when the Days

are

are ſhort, and the Winds rage: For, tho' the Soundings are of great Service, yet they are by no means to be relied on alone, nor can they be tried well in a great Sea; and tho' perhaps an Obſervation may be had, which gives a Latitude of 20 or 30 Miles to the South of the Parallel of *Scilly*, or the *Lizard*, yet it is dangerous venturing on to run up the Channel in dark Nights (eſpecially if it blow hard from the Southern Quarter, as frequently happens) ſince the Latitude by Obſervation is not to be depended on, and the Ship may be perhaps half a Degree to the Northward of the Parallel thus given by Obſervation; but had the Truth but been known, in the Time of Diſtreſs, when it was wanted, by an Obſervation that might be relied on, the Ship might have run boldly up the Channel, and attained her deſired Port in Safety; inſtead of which, by being forced to ſuch Caution, ſhe has laid expoſed, and perhaps been driven into, and embayed in the *Briſtol* Channel, or ſuffered ſome conſiderable Damage. The ſame may be ſaid of making the Southern Side of the Channel, towards the *French* Coaſt, when the Winds blow hard from the Northern Quarter, as well as in numberleſs other Examples, was it neceſſary.

Here follows, for the more ready Convenience of thoſe who may uſe this Inſtrument, the Directions for adjuſting the Glaſſes, and taking an Obſervation, extracted from the foregoing Sheets.

For adjuſting the Glaſſes,

FOR the Fore Obſervation, be careful to ſet the Index exactly to the Beginning of the Scale of Degrees; then, holding the Inſtrument with your Left-hand, by the middle Bar, as upright as you can, with the Arch downwards, and leaning your Body forwards, that you may not, by touching the Index, ſtir it from its Place, look through the lower Hole, in the Sight-Vane, which is next the Plane of the Inſtrument, and ſee the Edge of the Sea thro' the unquickſilvered Part of the Glaſs, and mark, whether the Line of the Sea's Edge, thus ſeen directly, join in one with the Edge ſeen by Reflection on the quickſilvered Part; if not, by the Key turn this Glaſs, till they join in one Line; then look again,

again, to ſee that the Index has not been ſtirred from its Place by any Accident.

For adjuſting the Back Obſervation, having firſt ſet the Index off ſo much before the Beginning of the Scale of Degrees, as is the Double of the Dip of the viſible Horizon, according to the Table for that Purpoſe hereunder annexed; and having ſhifted the Sight-Vane, look through the ſame Hole, in the ſame manner as for the adjuſting the Fore Obſervation, and ſee that the Edge of the Sea behind you, by Reflection, join with that ſeen directly forward; if not, adjuſt this Glaſs in like manner, by the Key, till they do.

To make an Obſervation, hold the Inſtrument as upright as you can, with the Arch downwards, pointing your View towards that Part of the Horizon, which is either directly under the Object, or oppoſite to it, according to which Obſervation is uſed, and then ſlide the Index, till you bring the Object above to appear in the Horizon. But to find the Sun more readily, as his Meridian Altitude is always known beforehand, to within a few Degrees, ſet the Index accordingly to the Altitude you reckon him to be in, and you will preſently find him near the Edge of the Sea. Then, by moving the Index, place

him exactly on it, and move the Inſtrument ſide-ways to right and left, and ſee that he runs exactly along upon the Edge of the Horizon, if he cuts it, the Inſtrument is not held upright.

In obſerving by the Sun, if he be not obſcure, look through the outward Hole in the Sight-Vane, and take his Image, on the Middle of the unquickſilvered Part of the Glaſſes, at the ſame time you ſee the Horizon directly through; if he be too bright, uſe the dark Glaſſes, which ſhift according to which Obſervation is uſed. But if the Sun be dim, take his Image on the quickſilvered Part, as near the Edge of the Quickſilver as conveniently may be, and looking through the unquickſilvered Part of the Glaſs, by the lower Hole in the Sight-Vane, at the Edge of the Sea, move the Index till you judge when that Line, if produced, cuts the Image of the Sun, as you would have it.

In the Fore Obſervation, if you uſe the under Edge of the Sun, add 16 Minutes for the Sun's Semidiameter, if the upper Edge, ſubſtract 16 Minutes.

In the Back Obſervation it is juſt the contrary; if you obſerve by the appearing under Edge, ſubſtract; if by the upper, add.

To

To obſerve by the Sun's Center will do, but is not ſo exact a Method.

To obſerve by a Star.

By the Fore Obſervation, look directly up at it firſt, with the Index at the Beginning of the Scale of Degrees; then move the Index forwards, and cauſe the Star to ſlide down to the Horizon, that you may not miſtake it for another.

By the Back Obſervation, look directly up at the Star, and ſlide the Index, till the Horizon, behind ſeen by Reflection, cuts it.

Here follows a Table of the Dip of the Viſible Horizon, which is the Edge of the Sea, below the true Horizontal Line, according to the Number of Feet the Eye of the Obſerver is elevated above the Surface of the Water; the Double of which is to be allowed, when the Index is ſet off before the Beginning of the Scale of Degrees, to adjuſt the leſſer Glaſs, uſed for the Back Obſervation.

Feet

Feet above the Surface of the Water	Dip
44	8 Minutes
34	7
25	6
17	5
11	4
6	3
3	2
1	1

If an Obſerver would be exact in his Obſervations, this Dip is always to be ſubſtracted from the Altitude found by the Fore Obſervation, and, in the Back Obſervation, always to be added.

N. B. *This is quite independant of the Directions above, for adjuſting the Back Obſervation; for it is, after that Adjuſtment, to be ſingly added to it in every Obſervation, as likewiſe ſubſtracted every time in the Fore One.*

FINIS.